

**IN THE UNITED STATES PATENT
AND TRADEMARK OFFICE**

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SECTION MILL FOR WELLS

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1 **I. TITLE: "SECTION MILL FOR WELLS"**

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3 **II. BACKGROUND OF THE INVENTION**

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5 **1. Field of the Invention.**

6
7 The present invention relates to a section mill for wells, and more
8 particularly, to a section mill that permits a user to extend the cutting
9 performance of the apparatus without retrieving it from the well.

10
11 **2. Description of the Related Art.**

12
13 In the operation of oil wells, it is common during the maintenance
14 stage to abandon the deepest portion of the casing (when it is in poor
15 conditions) and open a casing window to install a new casing portion,
16 typically, at an angle with respect to the previous casing, to reach oil
17 deposits through a new path. Section mills are utilized to mill portions of a
18 casing to accomplish this. In doing so, the casing needs to be cut from
19 inside the casing and, subsequently, longitudinally reduced. The blades
20 wear off and the conventional mills need to be retrieved to replace the
21 blades and reinsert the mill.

22
23 Many designs for section mills have been designed in the past. The
24 present invention includes a second set of blades that is deployed after the
25 first set has been consumed milling the casing portion being replaced. This
26 obviates the time consuming task of taking out the section mill assembly to
27 change the used up set of blades and replace it with a new one.

1 Applicant believes that the closest reference corresponds to U.S.
2 patent No. 5,074,355 issued to Lennon on December 24, 1991 for a section
3 mill with multiple cutting blades. Lennon's patented section mill for
4 cutting through well casing includes multiple sets of cutting blades which
5 are selectively engaged to continue cutting operations as blades dull. The
6 cutting blade sets are selectively indexable such that as a first set dulls or
7 fails a succeeding set can be utilized following retraction of the first set.
8 The section mill also includes a central mandrel having offset cammed
9 surfaces, which engage the cutting blades and cause them to expand
10 outwardly. The mandrel is axially displaceable by a piston affected by
11 hydraulic pressure. As the mandrel is axially displaced the indexed cutting
12 blades are expanded by the cammed surface. Indexing is accomplished by
13 a cam drum, which allows the mandrel to be rotated relative to the cutting
14 blades in order to align the next cammed surfaces with their respective
15 cutting blades.

16
17 However, it differs from the present invention because a mandrel for
18 indexing the blades is not required. In the present invention the second set
19 of blades is automatically deployed once the cut section of the casing is
20 reached. Subsequently, the second (or other blades) will not be used until
21 the first blade is completely worn off. This simpler approach eliminates
22 several critical elements required in Lennon's section mill.

23
24 Other patents describing the closest subject matter provide for a
25 number of more or less complicated features that fail to solve the problem
26 in an efficient and economical way. None of these patents suggest the
27 novel features of the present invention.

III. SUMMARY OF THE INVENTION

It is one of the main objects of the present invention to provide a tool for extending its performance of cutting a casing at predetermined depths in a well without requiring the withdrawal of the section mill tool.

It is another object of this invention to provide a section mill tool for wells that includes at least two sets of blade assemblies wherein at least one of the sets is distended after an initial section of the casing has been cut.

It is still another object of the present invention to provide a tool that is easy to install and operate.

It is yet another object of this invention to provide such a tool that is inexpensive to manufacture and maintain while retaining its effectiveness.

Further objects of the invention will be brought out in the following part of the specification, wherein detailed description is for the purpose of fully disclosing the invention without placing limitations thereon.

IV. BRIEF DESCRIPTION OF THE DRAWINGS

With the above and other related objects in view, the invention consists in the details of construction and combination of parts as will be more fully understood from the following description, when read in conjunction with the accompanying drawings in which:

Figure 1 shows a partial cross sectional view of the section mill tool assembly, inside an oil well bore.

Figure 2 is a cross sectional view of the section mill tool assembly, with the blades being distended against the casing by fluid pressure. The first set of blades start cutting the internal wall of the casing while the second set of blades comes in slidable contact with the casing.

Figure 3 represents a cross sectional view of the section mill tool assembly shown in the previous figures with the first set of blades beginning the casing sectioning work.

Figure 4 shows a cross sectional view of the section mill tool assembly, with the first set of blades fully distended sectioning the casing and the second set of blades continues in slidable contact with the internal walls of the casing.

Figure 5 shows a cross sectional view of the section mill tool assembly, with the first set of blades having sectioned a portion of the casing and being partially worn out. The second set of blades continues to be in slidable contact with the internal walls of the casing.

1
2 **Figure 6** illustrates a cross sectional view of the section mill tool
3 assembly, with the first set of blades having sectioned a sufficient portion of
4 the casing so its blades are almost completely used up and the second set of
5 blades has reached the portion already cut by the first set of blades
6 allowing it now to fully distend.

7
8 **Figure 7** shows a cross sectional view of the section mill tool assembly,
9 with the first set of blades completely used up and the second set is
10 advancing in the already cut portion.

11
12 **Figure 8** shows a cross sectional view of the section mill tool assembly,
13 with the first set of blades completely used up and the second set of blades
14 have advanced to reach the portion of the casing where the sectioning
15 operation needs to continue.

16
17 **Figure 9** shows a front isometric view of one of the blades used in the
18 first set of blades.

19
20 **Figure 10** shows a rear isometric view of one of the blades used in the
21 first set of blades.

22
23 **Figure 11** is a cross sectional view of the blade shown in figure 9
24 taken from line 11-11.

25
26 **Figure 12** shows a front isometric view of one of the blades used in the
27 second set of blades.

1 **Figure 13** shows a rear isometric view of one of the blades used in the
2 second set of blades.

3
4 **Figure 14** is a cross sectional view of the blade shown in figure 12
5 taken from line 14-14.

6
7 **Figure 15** shows an isometric view of the tubular shaft assembly
8 (partially shown) with tubular shaft assembly and second set of blades mounted
9 therein.

10
11 **Figure 16** is a cross section shown in figure 15 taken from line 16-16
12 showing the disposition of the blade assembly with respect to the shaft
13 assembly and the triangular cross section of the teethed portion.

14 15 **V. DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

16
17 Referring now to the drawings, where the present invention is
18 generally referred to with numeral **10**, it can be observed that it basically
19 includes casing **15**, cylindrical assembly **20**, tubular shaft assemblies **30** and
20 **40** and first and second sets of blades **50** and **60**, and their respective spring
21 bias assemblies **70** and **80**.

22
23 An oil well bore typically includes casing **15** that extends
24 downwardly several thousand meters. Sometimes a portion collapses
25 making it inoperational. Rather than closing the oil well and wasting the
26 associated infrastructure investment, a portion of the casing above the
27 problem area is sectioned and branched out to reach oil deposits through a
28 different path. With the present invention, the second set of blades is

1 deployed and used after the first set has been worn out completely. In
2 sum, the cutting and reliability capabilities of the section mill is extended.

3
4 In figure 1, the tool subject of the present application is shown within
5 an oil well casing, as it is being lowered to the desired location. There is
6 no pressurized fluid applied yet. Cylindrical assembly 20 extends for
7 several thousand meters and it includes central through opening 28
8 through which a source of a pressurized fluid (typically water) is forced
9 through. Uppermost end 22 is rotably supported at the well entrance at the
10 top. Assembly 20 includes apertures 24 and 26 at predetermined distances
11 from the distal end 23.

12
13 Tubular shaft assembly 30 includes central through opening 38 that is
14 coaxially aligned with central opening 28 of cylindrical assembly 20.
15 Tubular shaft assembly 30 also includes ends 32 and 33 and teathed
16 portions 34 at a predetermined distance from end 32. Tubular shaft
17 assembly 30 is coaxially housed within cylindrical assembly 20. Packing
18 member 36 seals shaft assembly 30 with respect to cylindrical assembly 20.
19 Packing member 36 is implemented, in the preferred embodiment with an
20 O-ring.

21
22 Tubular shaft assembly 40 includes ends 42 and 43, central through
23 opening 48 and teathed portions 44 (as best seen in figure 15) at a
24 predetermined distance from end 42. Tubular shaft assembly 40 is
25 coaxially housed within tubular shaft assembly 30. Packing member 46
26 seals shaft assembly 40 with respect to shaft assembly 40. Packing member
27 46 is implemented, in the preferred embodiment with an O-ring.

1 First set of blades 50 (upper ones) is rotatably mounted to cylindrical
2 assembly 20 at aperture 24. First set of blades 50 includes, in the preferred
3 embodiment, three blade members 52 selectively movable between two
4 extreme positions. Blade members 52 are cooperatively adapted to coact
5 with teathed portions 34. Blade members 52 are in a substantially coaxial
6 alignment with cylindrical assembly 20 in one of the extreme positions and
7 are in a substantially perpendicular relationship with respect to cylindrical
8 assembly 20 protruding radially outwardly therethrough in the other
9 extreme position. In the latter extreme position blade members 52 are
10 brought in operational contact with casing 15. Blade member 52 includes
11 smooth rounded corner 53, milling edge 54, internal channel 56, cutout 57
12 and teathed portions 58. Smooth corner 53 comes in slidably contact with
13 the interior surface of casing 15 when moving from the first extreme
14 position towards the other extreme position. Teathed portion 58 has
15 through opening 59 with cooperative dimensions to receive pin member 25
16 mounted to cylindrical assembly 20. In the preferred embodiment, pin
17 member 25 is securely locked with a fastening member. Teathed portions
18 58 of blade members 52 cooperatively coact with teathed portions 34 of
19 shaft assembly 30. Milling edge 54 of blade member 52 starts its cutting
20 operation only after section mill 10 advances downwardly a sufficient
21 distance to permit blades 52 to distend radially outwardly through casing
22 15 and blade members 62 have wore out. Blade member 52 is shown in
23 more detail in figures 12; 13 and 14. Member 52 also includes, in the
24 preferred embodiment, abrasive portion 51 that in turn includes steel
25 support plates 55 sandwiched by abrasive material layers 55'. One of the
26 preferred and hardest abrasive materials used for the present invention is
27 tungsten carbide.

28

1 Second set of blades 60 is mounted to cylindrical assembly 20 at a
2 predetermined distance from end 23. The distance between the location of
3 the second set of blades 60 and end 23 is shorter than the distance between
4 the location of first set of blades 50 and end 23. Blade members 62 are
5 cooperatively adapted to coact with teathed portions 44. Teathed portion
6 68 has through opening 69 with cooperative dimensions to pivotally
7 receive pin member 27 mounted to cylindrical assembly 20. In the
8 preferred embodiment, fastening member 29 securely locks pin member 27,
9 as best seen in figures 15 and 16. Second set of blades 60 includes, in the
10 preferred embodiment, three blade members 62 selectively movable
11 between two extreme positions. Blade members 62 are in a substantially
12 coaxial alignment with cylindrical assembly 20 in one of the extreme
13 positions and are in a substantially perpendicular relationship with respect
14 to cylindrical assembly 20, and protruding radially outwardly through, in
15 the other extreme position. In this other position, blade members 62 are
16 brought in operational contact with casing 15. Blade member 62 is shown
17 in more detail in figures 9; 10 and 11. In the preferred embodiment,
18 abrasive portion 61 includes steel support plates 65 sandwiched by
19 abrasive material layers 65'. Tungsten carbide is the preferred abrasive
20 material used. Blade member 62 also includes cutting corner 63, milling
21 edge 64, internal channel 66, cutout 67 and teathed portions 68. Cutting
22 corner 63 is designed to start the cutting operation from the internal surface
23 of casing 15.

24
25 Spring bias assembly 70 urges end 43 of tubular shaft assembly 40
26 towards end 22 and is overcome by the application of a source of
27 pressurized fluid through central through opening 28 of cylindrical
28 assembly 20 coacting against the surface of end 43 of tubular shaft

1 assembly 40, so that blade members 62 are brought against casing 15 to
2 start the cutting operation. Corner 63 of blade member 62 comes in contact
3 with the internal surface of casing 15 and the cutting operation starts.
4

5 Spring bias assembly 80 urges end 33 towards end 22 and overcome
6 by the application of a source of pressurized fluid through cylindrical
7 assembly 20 coacting against end 33 of tubular shaft assembly 30, so that
8 blade members 52 are brought against casing 15 in slidably contact
9 therewith thereby starting the cutting operation only after the mill 10 has
10 advanced a predetermined distance and blades 62 have been consumed.
11

12 The foregoing description conveys the best understanding of the
13 objectives and advantages of the present invention. Different embodiments
14 may be made of the inventive concept of this invention. It is to be
15 understood that all matter disclosed herein is to be interpreted merely as
16 illustrative, and not in a limiting sense.